BELLCOMM, INC.
1100 Seventeenth Street, N.W. Washington, D. C. 20036

SUBJECT: Boeing - Saturn V/Apollo Technical Integration and Evaluation Quarterly Review - Case 320

DATE: July 17, 1968

FROM: A. Bresnick

ABSTRACT

This memorandum presents highlights of the Boeing Saturn V/Apollo Technical Integration and Evaluation Quarterly Review held June 19, 1968, at MSFC.

Significant items discussed were:

1. Saturn V Stage Storage
2. Saturn V Launch Vehicle Availability
3. SE&I Manrating Study
4. Systems Development Facility Time Requirements
5. AS-502 133 Second Transient and POGO

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MEMORANDUM FOR FILE

The writer visited MSFC to attend the above review on June 19, 1968. Attachment 1 contains a copy of the agenda. A copy of the charts is available from the writer. Following are significant items which were discussed.

1. Saturn V Stage Storage

The acquisition of Saturn V stages is significantly in advance of their usage rate. Long term storage requirements are creating problems. Boeing recommends that (1) emphasis be placed on storage economies rather than slowing production; and (2) specifications and contracts be executed to cover this area.

2. Saturn V Launch Vehicle Availability

Simulation model data for the Saturn V vehicle indicates an availability of 0.50 for a 3-hour launch window. This covers a period of 26.0 hours from L-1 day to lift-off and includes 2.3 expected failures with a Mean-Time-To-Repair (MTTR) of 2.7 hours.

Figure 1 indicates the effects of launch window length on launch vehicle availability for AS-504. As the launch window increases in time, the launch vehicle availability increases to a maximum approaching 0.85. Various methods are under study to improve the launch vehicle availability.

3. SE&I Manrating Study Group

An analysis was made of documents from three levels: (1) Apollo - Program Development Plan, Program Specification, Test Requirements, Reliability and Quality Assurance Plans, Program Directives; (2) Saturn V - Program Specifications and Program Directives; and (3) End Item - S-IC Contract End Item Specifications and KSC LSE/GSE Specifications.

The study showed that:

a. Manrating requirements were widely scattered.

b. Manrating requirements have been inconsistently levied.

c. Some important manrating requirements did not appear in the sampled documentation.

d. Documented requirements are incomplete and they do not adequately provide specifications for:

(1) Elimination of the possibility of single human acts leading to catastrophe.

(2) Prelaunch checkout of critical functions.

(3) Provision of a positive performance capability margin for critical equipment.

(4) Evaluation of the risks of environmental deltas from demonstrated missions.

(5) Evaluation of human performance in the spacecraft to avoid being compromised by launch vehicle induced environments.

4. Systems Development Facility (S-V Breadboard)

There is a lack of available regular hours to satisfy projected time requirements to be levied on the Systems Development Facility (SDF) in support of accelerated vehicle checkout at KSC. Extra hours are needed to meet realistic requirements. AS-501 and 502 which were unmanned flights had as much time available as was necessary; however, AS-503, the first manned Saturn V, does not have sufficient time available for necessary SDF work.

5. AS-502 133 Second Transient and POGO

a. A task team assembled to study the 133 second anomaly concluded that:

(1) The transient was structural in origin

(2) The launch vehicle responded structurally in all stages except the S-IC

(3) The launch vehicle responded electrically in all stages

(4) There was no structural failure or detrimental effect in the launch vehicle

(5) The launch vehicle electrical effects were not detrimental and did not contribute to launch vehicle flight anomalies

(6) One or more failures were likely in the spacecraft

Figure 2 shows the AS-502 total combined load at station 3258 compared with structural capability. The location of the 133 second transient can be compared with the time period for POGO which is taken from figure 3 as approximately 105 to 137.5 seconds.

b. Figure 3 shows the AS-502 longitudinal acceleration measured on the S-IC gimbal block. Dynamic responses occurred at liftoff, max Q region, and during the POGO time periods. The effect of POGO on the longitudinal acceleration is quite apparent. As indicated above, the 133 second transient occurred during the POGO time span which was approximately 105 to 137.5 seconds.

Figure 4 shows the POGO oscillation as recorded in the IU. For a frequency of 5.0 to 5.4 HZ, the figure shows a maximum POGO of $\pm$ 0.2 G's. The time span of 125 to 126 seconds includes the POGO peak, judging from figure 3.

Figure 5 shows the LM ascent stage dynamic coupling as a result of the POGO oscillation. The figure shows that at a frequency of about 5 HZ the coupling reaches a peak of about 100% in the longitudinal direction and ranges down to 70% for pitch and 10% for yaw.

A. Bresnick

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Attachments

TECHNICAL REVIEW AGENDA

SATURN V/APOLLO TECHNICAL INTEGRATION AND EVALUATION PROJECT REVIEW

PERIOD: February 1, 1968 through May 31, 1968

DATE: June 19, 1968

LOCATION: MSFC Building 4200, Room P-114

CO-CHAIRMEN: H. W. Strickland and M. W. Sanders

PARTICIPANTS: MSFC and The Boeing Company

TECHNICAL REVIEW

TIME		TASK AND SUBJECT	SPEAKER
8:45 a.m.	I.	SATURN V/APOLLO TIE INTRODUCTION - MSFC	H. W. Strickland
9:00 a.m.	II.	SATURN V/APOLLO TIE TECHNICAL REVIEW PRESENTATION	F. B. Williams
9:10 a.m.		A. APOLLO TIE INTRODUCTION	F. B. Williams (10 Min.)
9:20 a.m.		B. SE&I INTRODUCTION	F. B. Williams (5 Min.)
		C. SYSTEM INTEGRATION	
9:25 a.m.		6.0 Program Control	C. P. Black (10 Min.)
9:35 a.m.		7.0 Configuration Management	J. H. Walker (10 Min.)
9:45 a.m.		1.0 Test Program Integration and Launch Readiness Assessment	J. G. Henry (5 Min.)

		LUNCH	
1:30 p.m.	IV.	LV&MGSE INTRODUCTION - MSFC	M. W. Sanders
1:35 p.m.	V.	LV/MGSE TECHNICAL REVIEW PRESENTATION	F. B. Williams (5 Min.)
1:40 p.m.		A. 5.0 LOGISTICS	O. A. Morard (10 Min.)
1:50 p.m.		B. 10.0 SYSTEMS DEVELOPMENT FACILITY	F. E. Lumbard (10 Min.)
2:00 p.m.		C. 13.0 & 14.0 MGSE TECHNICAL EVALUATION AND RECOMMENDATIONS	E. G. Cowart (15 Min.)
2:15 p.m.	VI.	LV/MGSE SUMMARY	F. B. Williams (5 Min.)
2:20 p.m.	VII.	REVIEW AND ASSIGNMENT OF ACTION ITEMS	M. W. Sanders
		ADJOURN	

TIME	TASK AND SUBJECT		SPEAKER
9:50 a.m.	10.0	Logistics	O. A. Morard (5 Min.)
9:55 a.m.	COFFEE BREAK		
10:05 a.m.	D. SYSTEMS ENGINEERING		
	SYSTEM REQUIREMENTS		W. S. EZELL (15 Min.)
	7.6.2	Interface Engineering	
	11.7.9	Missions Rules	
10:20 a.m.	SYSTEM DEFINITION		W. S. Ezell (15 Min.)
	5.11	System Definition	
	5.2.1	Composite Mechanical Schematics	
	2.2.2	Ordnance System Document	
	5.9	Technical Information Program	
	10.4	Saturn Flight Manual	
10:30 a.m.	PRELAUNCH SYSTEM ANALYSIS		W. J. Larson (15 Min.)
	3.2 3.1	Operations Analysis & Maintenance Analysis	
10:45 a.m.	5.4	Design Certification Review	W. S. Ezell (5 Min.)
10:50 a.m.	SAFETY & RELIABILITY ASSURANCE		W. B. Dalrymple (15 Min.)
	5.3	Reliability Analysis	
	11.4	Systems Parts Assurance	
	11.5 & 11.6	Saturn/Apollo System Safety Program	
11:05 a.m.	E. TECHNOLOGY		E.G. Cowart (40 Min.)
	8.0	Flight Vehicle Systems Analysis	
	-	Introduction	
	-	Flight Evaluation	
	-	Flight Mechanics and Dynamics	

EVALUATION OF SYSTEM EFFECTIVENESS

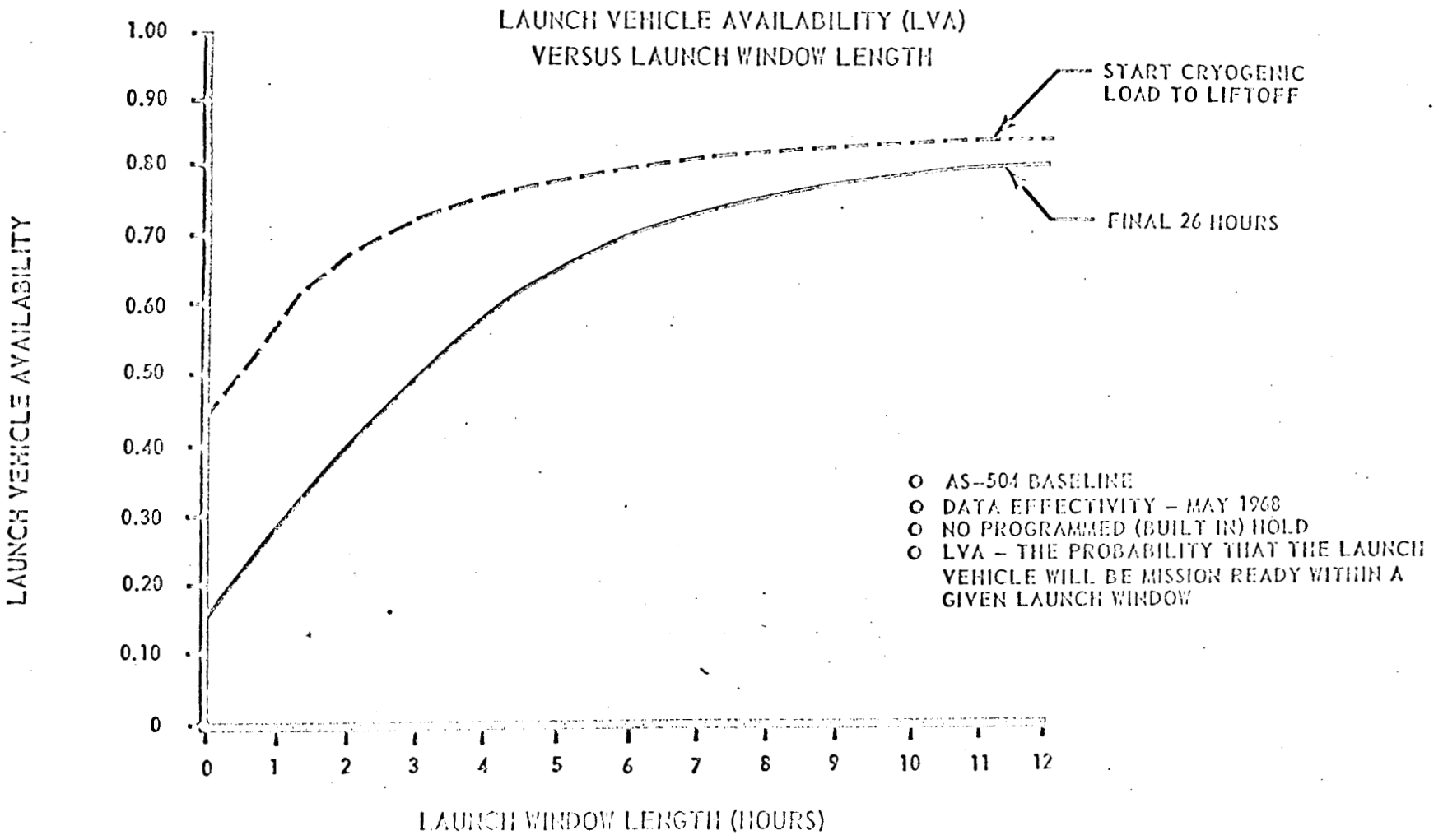


FIGURE 1

AS-502 LOADS AT STATION 3258

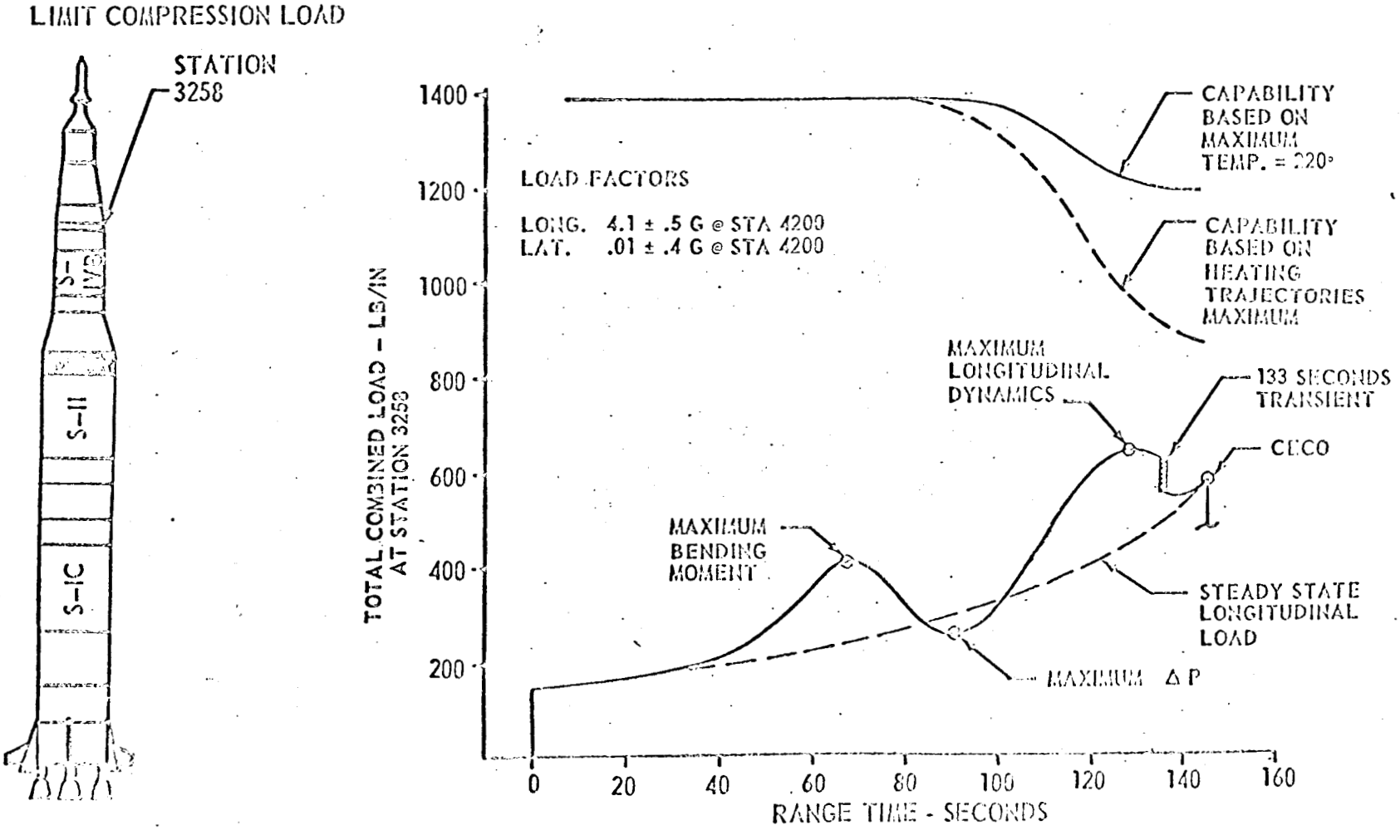
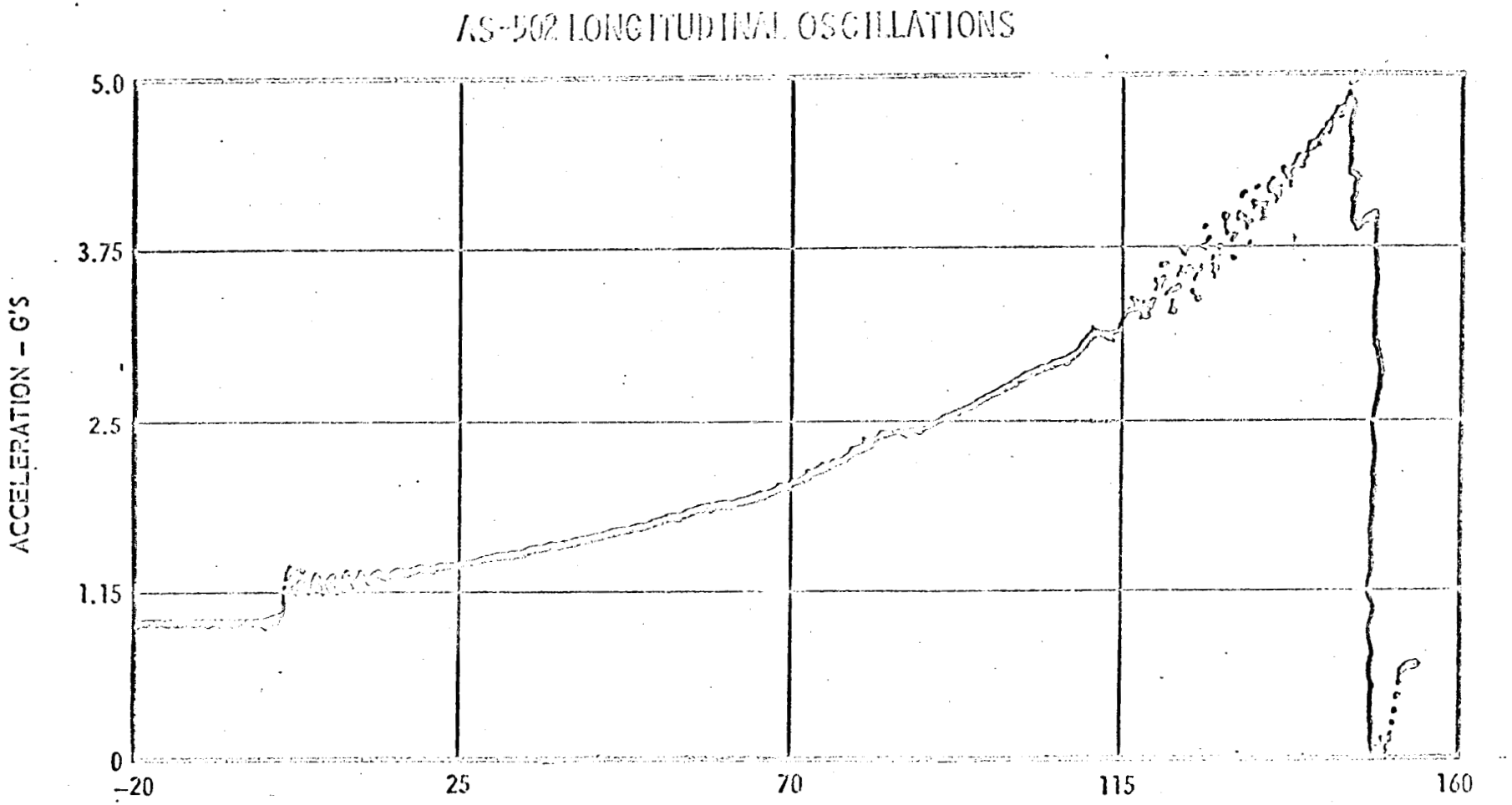


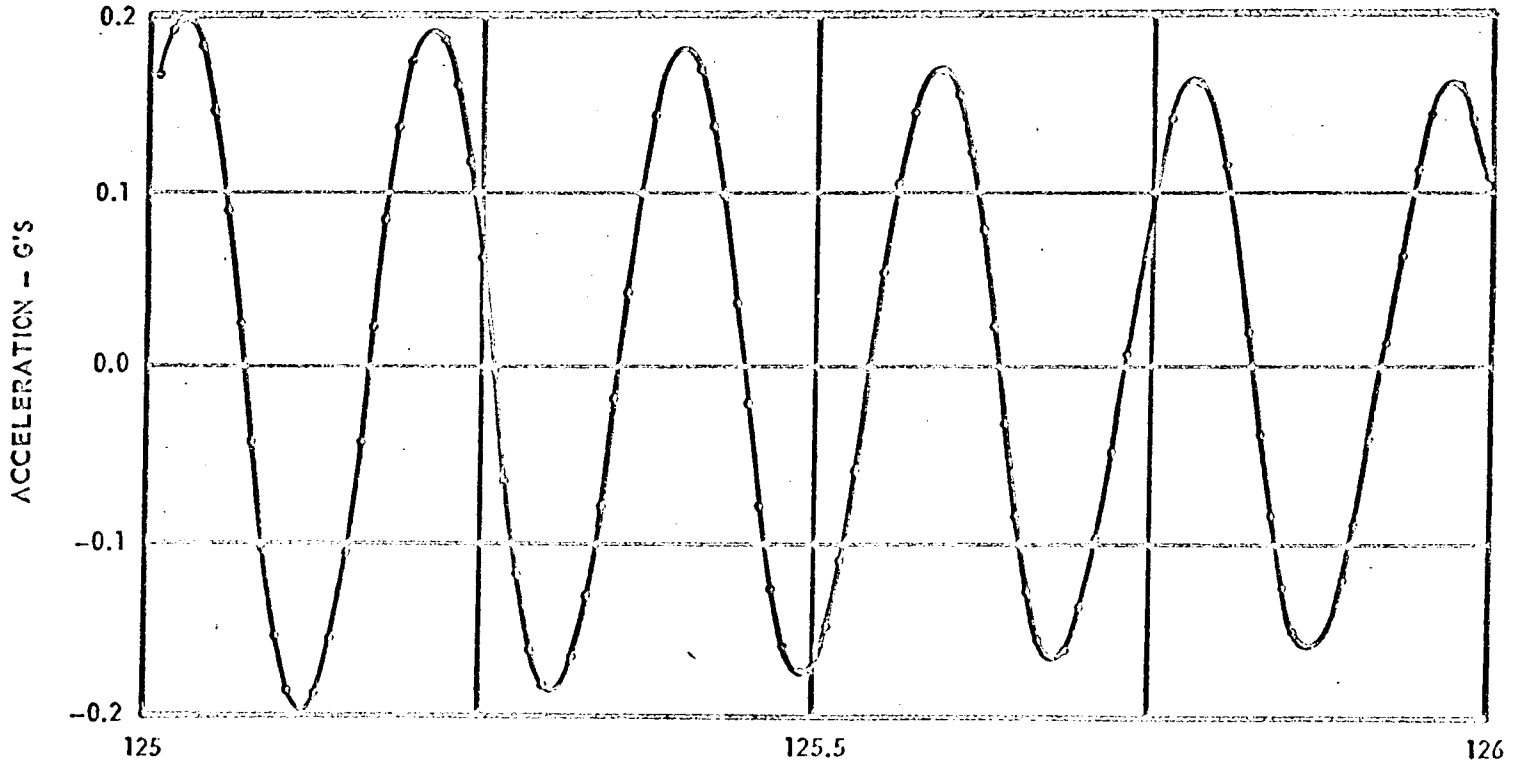
FIGURE 2



LONGITUDINAL ACCELERATION TIME HISTORY
THROUGH S–IC BURN AT S–IC GIMBAL BLOCK AS–502

FIGURE 3

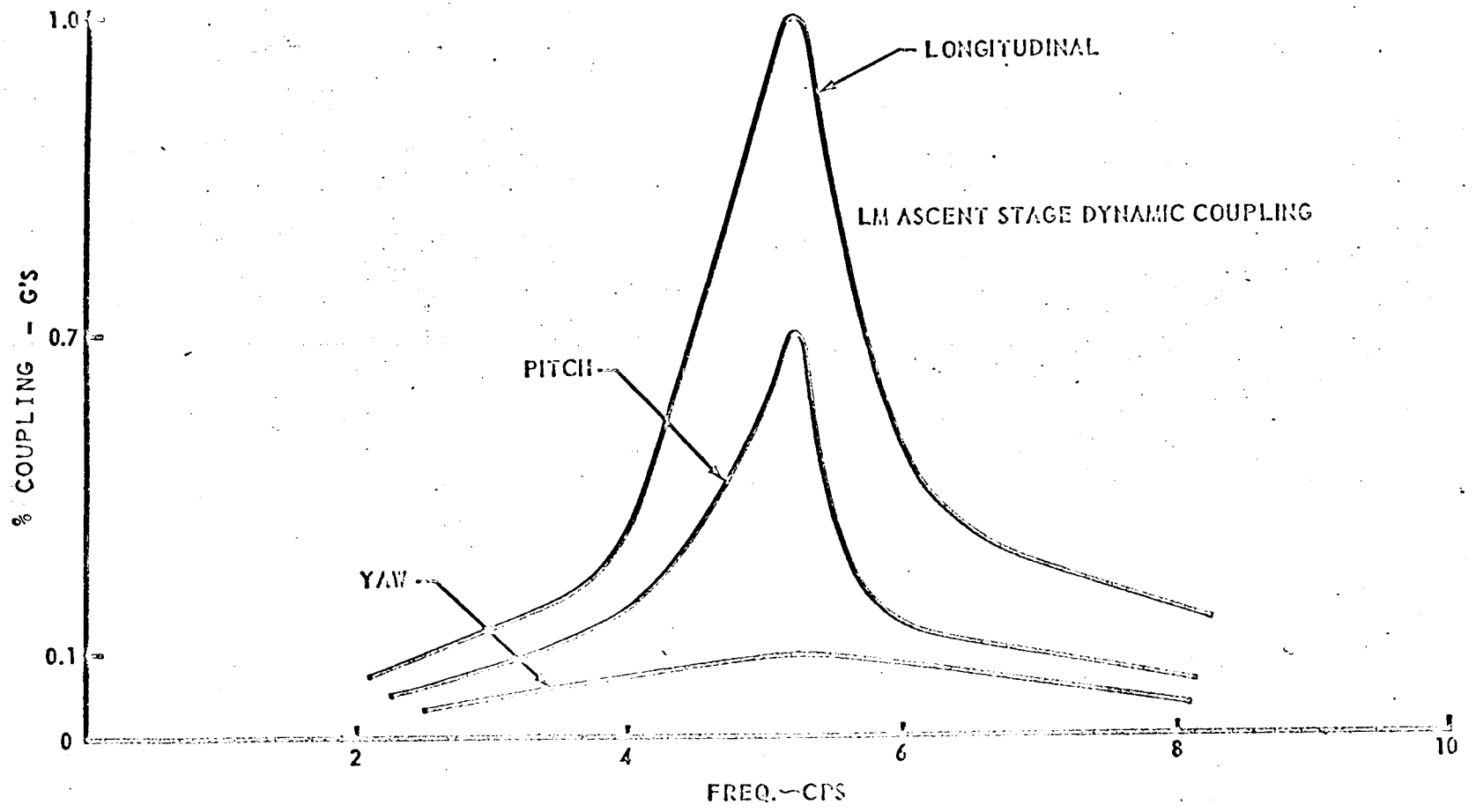
AS-502 LONGITUDINAL OSCILLATIONS



LONGITUDINAL DYNAMICS – THROUGH 5.0 TO 5.4 CPS
BANDPASS FILTER. MEASUREMENT A2–603 IN I.U.

FIGURE 4

AS-502 LONGITUDINAL OSCILLATIONS



% COUPLING VERSUS FREQUENCY T = 120–125 SEC.

FIGURE 5

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